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Remote Operation and Performance of the AuScope VLBI Array

Jamie McCallum [1], James Lovell [1], Stanislav Shabala [1], John Dickey [1], Christopher Watson [2], Oleg Titov [3]

1) *School of Mathematics and Physics, University of Tasmania*
2) *School of Geography and Environmental Studies, University of Tasmania*
3) *Geoscience Australia*

Contact author: Jamie McCallum, e-mail: `Jamie.McCallum@utas.edu.au`

Abstract

The AuScope VLBI array consists of three Australian 12-m telescopes located in Hobart (Hb), Katherine (Ke), and Yarragadee (Yg). The full array commenced operations with the IVS in June 2011. The telescopes are operated by the University of Tasmania and are all controlled from an operations center at the University's main campus. With two telescopes located in distant remote sites with limited local support, it has been vital to have a reliable and comprehensive remote observing system. A short outline of the system and the current performance of the telescopes is given below.

1. Introduction

With three telescopes separated by ∼3000 km from each other, and with limited local support available at two sites, a reliable system for remote operation and monitoring is critical. This report outlines the system in use for the AuScope array as well as the current performance of the AuScope telescopes. For a more complete overview of the AuScope array and its role in IVS operations, please refer to Lovell et al. 2012 (this volume).

2. Control & Monitoring Systems for Remote Operations

The control of the AuScope array is carried out from an operations center, located on the University of Tasmania campus. The individual telescopes are connected to the University's network. Each site has two independent network connections to provide reliable access.

The AuScope antennas use a standard PCFS configuration (using the current 9.10.04 version) with customized modules for antenna control and system monitoring. The PCFS host machines are server-class machines using RAID file systems for reliability.

Control and monitoring of the experiments is carried out using the eControl interface for the field system, together with the Open-MoniCA system. eControl was developed by [1] and offers significant benefits in bandwidth usage and connection reliability for the remote sites, compared to alternatives such as VNC. The MoniCA system was originally designed for the Australia Telescope Compact Array (ATCA), and it collects information on the observing system from a number of monitoring points. For the AuScope array, this encompasses supply voltages for the receiver electronics, temperature and humidity in the antenna structure, wind conditions, drive parameters, generator battery voltages, and so on. Most of the analog interfaces are provided by PICAXE-based devices which are interfaced to MoniCA via simple TCP servers. All of the information collected by MoniCA is permanently logged to assist in post-facto fault finding. A real-time monitoring system is also present to detect any faults when they occur, and to warn the operator. Informational displays are used in the control center to provide operators with a summary of important information. The open-MoniCA system in currently under active development to improve its performance and to offer a number of new features such as a Web-interface system and finer control of the alarm system.

All the systems in the AuScope array have been standardized as much as possible, in order to make troubleshooting and replacement of units easier. The basic operation of the array consists of a number of modular units. The IF signal first passes through the IF unit, and then into the DBBC for sampling. The sampled data is then recorded to disk using a Mark 5B+ unit. All of the IF and recording systems are controlled by the PCFS machine.

The IF unit consists of four IF chains (RCP and LCP of S- and X-band), each with tuned cable compensators, IF amplifiers, and independent controllable attenuator array. The output of each IF is split with two outputs going to the inputs of the DBBC conditioning modules, together with one other output as an analog monitor point. In usual operation, these monitoring points are connected to a remotely controlled selector device which determines the input to the Agilent power sensor. A network-accessible spectrum analyzer is also connected to this analog monitor point. This is particularly useful for detecting the presence of RFI.

3. Performance

During the commissioning of the antennas and after any work on the receiver system, the system temperature is measured using a warm load. Using the nominal LNA temperatures, the inferred system temperature is generally in the range of 85-90 Kelvin for a system in good order. The SEFD of the telescope was estimated using sources from the [2] catalog as flux calibrators, primarily Virgo A and Hydra. The zenith SEFD of the AuScope antennas is estimated at ∼3500 Jy for both S- and X-band. A plot of the current performance of the Hobart 12-m telescope is included in Figure 1.

The gain of the telescope was measured using observations of sources that transit near to the zenith. The amplitude of the sources relative to the noise diode was measured at elevations between 10 and 85 degrees. At S-band, there is no evidence for any change with respect to elevation with an estimated aperture efficiency of 60%. At X-band, the optimal gain is seen at an elevation of 55 degrees, and a slight decrease is apparent toward the zenith and horizon. The peak aperture efficiency is 63.8%, decreasing to 60% at the zenith. The gain curve was estimated via a polynomial fit which is included here and shown in Figure 2.

$$\mathrm{ApertureEfficiency} = -2.77 \times 10^{-5}\ \mathrm{El}^2 + 3.03 \times 10^{-3}\ \mathrm{El} + 0.555 \tag{1}$$

The pointing model is currently implemented through the drive controller itself, which accounts for structural offsets such as tilts and encoder offsets. The RMS pointing accuracy across the sky is estimated at 45 arcseconds. The effect of these pointing errors should be a loss of $\leq 1\%$ at X-band. The pointing model and error estimates were obtained using grid-like observations. Further improvements should be possible using cross-scans of the source. While the antenna controller does support this, it is not presently integrated into the field system.

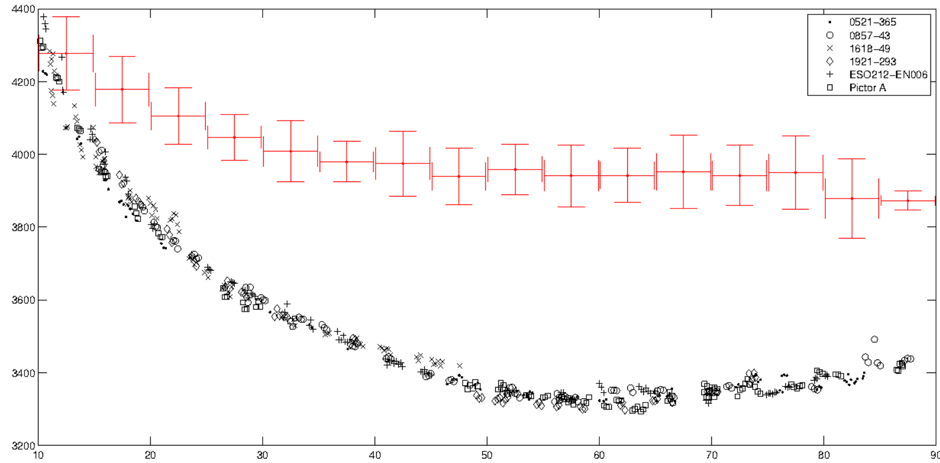

Figure 1. SEFD performance of the Hobart 12-m telescope. The X-band measurements are in black with the different symbols indicating the source. The S-band observations have been averaged across elevation and are plotted are in red. The averaging was necessary as S-band is considerably noisier due to terrestrial interference. The S-band system was suffering from a slightly elevated system temperature when these measurements were made.

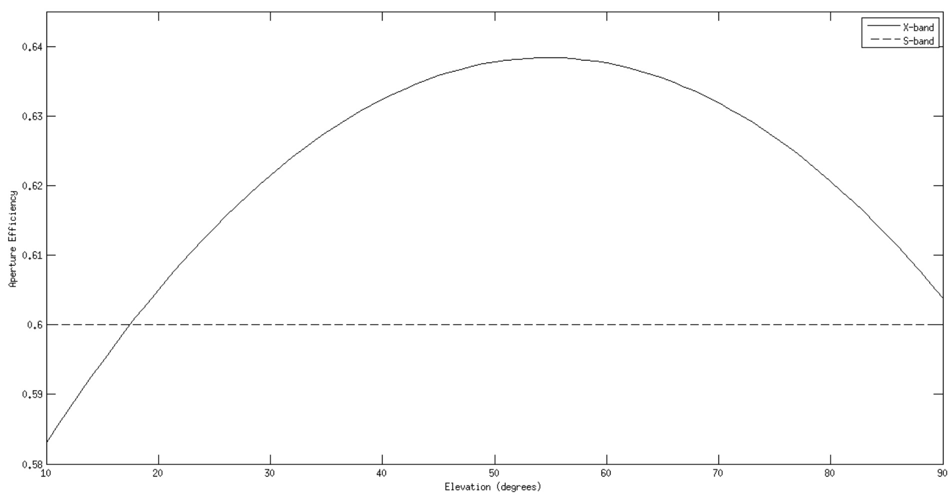

Figure 2. Estimated aperture efficiency for the Hobart 12-m telescope.

References

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